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Flower Classification using Pre-trained ResNet Models in Computer Vision

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***Abstract*— This report explores a methodology for flower classification using a pre-trained ResNet model. The approach involves fine-tuning the ResNet model on a flower dataset to achieve high classification accuracy. Key processes include data preprocessing, augmentation, model training, and evaluation, resulting in a validation accuracy of 95%. The project "Flower Classification Using Pre-trained ResNet Models in Computer Vision" aims to explore the capabilities of advanced deep learning techniques in accurately classifying flower species. Leveraging pre-trained Residual Networks (ResNet), this study demonstrates the efficacy of transfer learning in the domain of image classification, particularly for flora identification. This abstract outlines the methodology, key findings, and potential applications of the project, emphasizing the significant improvements in classification accuracy and computational efficiency achieved through the use of pre-trained models.**

***Index Terms*— Flower Classification, Pre-trained ResNet Models, Computer Vision, Deep Learning, Image Recognition, Convolutional Neural Networks, Transfer Learning, Flower Species Identification, Artificial Intelligence, Machine Learning, Neural Networks, Visual Processing, Dataset, Image Analysis, Feature Extraction, Model Training, Accuracy, Performance Evaluation, Image Classification, Flower Dataset.**

I. INTRODUCTION

Image classification is a pivotal task in computer vision with applications in various fields such as botany, healthcare, and agriculture. This study employs the ResNet model, known for its deep architecture and ability to mitigate the vanishing gradient problem, to classify images of flowers into multiple categories [1]. Flower classification is a challenging task in computer vision due to the diverse morphological characteristics of flowers. Traditional image processing techniques often fall short in handling the complexity and variability in flower images. Deep learning, particularly Convolutional Neural Networks (CNNs), has revolutionized image classification tasks by learning hierarchical feature representations. Among CNN architectures, ResNet stands out for its deep layers and residual connections that mitigate the vanishing gradient problem, enabling the training of very deep networks [2].

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II. PROPOSED RESEARCH METHODOLOGY

The project employed a transfer learning approach, utilizing pre-trained ResNet models trained on the ImageNet dataset. Transfer learning allows the model to leverage learned features from a vast collection of images, significantly enhancing its ability to generalize to new tasks with limited data. The methodology involved several key steps [3]:

- *Data Collection and Preprocessing*: A dataset comprising various flower species was curated. Images were preprocessed using libraries such as NumPy and Pandas for numerical operations and data manipulation. Techniques like resizing, normalization, and augmentation (via Keras preprocessing tools) were applied to improve the model's robustness and generalization capabilities [4].
- *Model Architecture*: The pre-trained ResNet model was fine-tuned for the specific task of flower classification. Additional layers were added to the base model to adapt it to the target dataset. The Keras framework was used to streamline the model building and training process [5].
- *Training and Optimization*: The model was trained using advanced optimization algorithms provided by Keras optimizers to minimize the loss function. TensorFlow Hub facilitated the seamless integration of pre-trained models. Keras callbacks such as ModelCheckpoint and EarlyStopping were employed to save the best-performing models and prevent overfitting [6].
- *Evaluation:* The model's performance was evaluated using Scikit-learn metrics, including accuracy_score, f1_score, recall_score, and precision_score. These metrics provided a comprehensive assessment of the model's classification capabilities [7].

III. METHODOLOGY

A. Dataset

The dataset consists of flower images categorized into multiple classes. Each image is labeled with the respective flower class [8].

B. Preprocessing

Images are resized to 224x224 pixels to match the input size expected by the ResNet model [9].
Data augmentation techniques are applied to increase the diversity of the training data, including random rotations, horizontal flips, and zoom operations [10].

C. Model Architecture

A pre-trained ResNet model is used as the base model. The pre-trained weights are leveraged to take advantage of features learned on a large dataset [11].
The final fully connected layers of ResNet are replaced with layers tailored for the flower classification task. This includes a global average pooling layer followed by dense layers leading to a softmax output [11].

D. Training

The model is compiled with the Adam optimizer and Sparse Categorical Crossentropy loss function [12].
Early stopping is employed to prevent overfitting by monitoring the validation loss and halting training when performance ceases to improve [14].
Learning rate reduction on plateau is used to dynamically adjust the learning rate during training for better convergence [13].

E. Evaluation

The model's performance is evaluated using accuracy and loss metrics on the validation set [15].
Confusion matrices and accuracy/loss curves are used to visualize and analyze the model's performance.
The system’s performance is fine and working satisfactorily [16].

IV. SIMULATION RESULTS & DISCUSSIONS

The fine-tuned ResNet model achieves a validation accuracy of 95%. The confusion matrix indicates high precision and recall for most classes, with minor misclassifications in similar-looking flowers. Accuracy and loss curves demonstrate stable training and convergence. The pre-trained ResNet model demonstrated high accuracy and robust performance in classifying flower species. The transfer learning approach significantly reduced the training time and computational resources required, while also achieving superior performance compared to models trained from scratch. The high f1_score and precision_score indicated the model's reliability in making accurate predictions, while the recall_score highlighted its effectiveness in capturing true positive instances [17].

V. SOFTWARE

Kaggle Notebooks is a cloud-based computational environment that supports reproducible and collaborative data analysis [30]. It is particularly useful for data scientists and researchers as it provides an integrated platform for coding, running, and sharing Jupyter notebooks. This environment facilitates seamless collaboration by allowing multiple users to work on the same project simultaneously, sharing insights and analyses in real time [18].

Data handling in Kaggle Notebooks is efficiently managed through various powerful libraries. NumPy is utilized for numerical operations on arrays, providing support for large, multi-dimensional arrays and matrices. Pandas is essential for data manipulation and analysis, offering data structures and functions needed to work on structured data seamlessly [28]. For data visualization, Seaborn and Matplotlib Pyplot are key; Seaborn provides an interface for creating informative and attractive statistical graphics, while Matplotlib Pyplot is used for plotting graphs and visualizations, allowing users to generate a wide variety of static, animated, and interactive plots [29]. The Random library is employed for generating random numbers, crucial for simulations and random sampling. Matplotlib Image aids in loading images into arrays, and the OS library is used for interacting with the operating system to handle file paths and directories [19].

In machine learning and model evaluation, Scikit-learn and TensorFlow with Keras play pivotal roles. Scikit-learn offers metrics for evaluating model performance, including accuracy_score, f1_score, recall_score, and precision_score, which provide comprehensive assessments of a model's effectiveness. TensorFlow, a core deep learning framework, and its high-level API, Keras, streamline the creation and training of neural networks [26]. Keras models allow for the creation of linear stacks of layers, Keras layers facilitate the building of various neural network layers, and Keras preprocessing enables real-time data augmentation, enhancing the training dataset through transformations like rotations and shifts. Optimization algorithms in Keras optimizers improve the model's performance by minimizing the loss function [27]. TensorFlow Hub provides access to pre-trained models, which can be fine-tuned for specific tasks, significantly reducing the time required for training. Keras callbacks, such as ModelCheckpoint and EarlyStopping, are used to save models during training and stop training early if the performance ceases to improve, respectively [20].

Model evaluation is an integral part of the machine learning workflow. Scikit-learn metrics like accuracy_score, f1_score, recall_score, and precision_score are crucial for quantifying the model's performance. These metrics offer insights into the model's accuracy, balance between precision and recall, and overall reliability. Custom scripts or code may also be developed to tailor the Flower Classification model, enhancing its accuracy and adapting its behavior or appearance to specific requirements. This customization can involve feature engineering, hyperparameter tuning, and incorporating domain-specific knowledge into the model [21].

In summary, Kaggle Notebooks, combined with robust libraries and frameworks such as NumPy, Pandas, Seaborn, Matplotlib, Scikit-learn, and TensorFlow with Keras, provide a comprehensive ecosystem for developing, training, and evaluating machine learning models. These tools collectively enable efficient data handling, deep learning, model evaluation, and customization, paving the way for advanced analyses and innovative solutions in projects like Flower Classification [22].

The following are the software models …..

- *Kaggle Notebooks* : Kaggle Notebooks is a cloud computational environment that enables reproducible and collaborative analysis.
- *Data Handling:*
- *NumPy* : For numerical operations on arrays.
- *Pandas* : For data manipulation and analysis.
- *Seaborn* : For data visualization.
- *Random*: For generating random numbers.
- *Matplotlib Image* : For image loading.
- *OS*: For operating system-dependent functionality.
- *Matplotlib Pyplot* : For plotting graphs and visualizations.
- *Scikit*-learn:
- *metrics*: For evaluating model performance.
- *TensorFlow and Keras*:
- T*ensorFlow* : Core deep learning framework.

- *Keras models* : To create a linear stack of layers.
- *Keras layers* : For building neural network layers.
- *Keras preprocessing* : For real-time data augmentation.
- *Keras optimizers* : For optimization algorithms.
- *TensorFlow Hub* : For loading pre-trained models.
- *Keras callbacks* : For saving models and stopping training early if needed.
- *Model Evaluation*:
- *Scikit-learn metrics*:
- *accuracy_score*: For calculating accuracy.
- *f1_score*: For calculating the F1 score.
- *recall_score*: For calculating recall.
- *precision_score*: For calculating precision.
- *Custom Scripts or Code*: Custom scripts or code may be developed to customize the behavior or appearance of the Flower Classification model **-** this can include scripts for enhancing the model's accuracy [23].

VI. APPLICATIONS

The successful implementation of this project highlights numerous practical applications. In the field of botany and agriculture, automated flower classification can aid researchers in identifying and cataloging plant species, thus contributing to biodiversity studies and conservation efforts [25]. Additionally, integrating such models into mobile applications can provide users with real-time flower recognition capabilities, enhancing educational tools and promoting environmental awareness [24].

VII. CONCLUSIONS

The experiment confirms that fine-tuning a pre-trained ResNet model is effective for flower classification, achieving a high validation accuracy. Future work could explore other deep learning architectures, larger datasets, and real-world applications to further validate and enhance model performance. The project titled "Flower Classification Using Pre-trained ResNet Models in Computer Vision" aimed to leverage advanced deep learning techniques and pre-trained ResNet models for the accurate identification and classification of flower species. This comprehensive study has successfully demonstrated the potential and efficacy of using pre-trained convolutional neural networks (CNNs) for image classification tasks, particularly in the domain of flora recognition.

ResNet, or Residual Network, is known for its deep architecture that helps mitigate the vanishing gradient problem, enabling the training of very deep networks. By utilizing pre-trained ResNet models, this project capitalized on the robustness and generalization capabilities inherent in models trained on large datasets such as ImageNet. The transfer learning approach significantly reduced the computational resources and time required for training, while also improving the classification accuracy by leveraging learned features from a vast collection of images.

The project effectively handled data using essential libraries such as NumPy, Pandas, and Seaborn for numerical operations, data manipulation, and visualization, respectively. Image data preprocessing, which included resizing, normalization, and augmentation, was crucial in improving the model's performance. Real-time data augmentation techniques, implemented through Keras preprocessing tools, enhanced the dataset by generating varied versions of the training images, thus increasing the model's ability to generalize and recognize flowers in diverse conditions. The training process was streamlined using Keras, with a focus on fine-tuning the pre-trained ResNet model. Various layers were added or modified to adapt the network to the specific task of flower classification. The optimization process employed advanced algorithms provided by Keras optimizers to minimize the loss function effectively. The use of TensorFlow Hub facilitated the seamless integration of pre-trained models, while Keras callbacks like ModelCheckpoint and EarlyStopping ensured efficient training by saving the best-performing models and preventing overfitting.

Model performance was evaluated using Scikit-learn metrics such as accuracy_score, f1_score, recall_score, and precision_score. These metrics provided a comprehensive assessment of the model's classification capabilities. The results indicated that the pre-trained ResNet model achieved high accuracy and robust performance in distinguishing between different flower species. The high f1_score and precision_score demonstrated the model's ability to make reliable predictions, while the recall_score highlighted its effectiveness in capturing true positive instances.

The success of this project highlights the practical applications of using pre-trained ResNet models in various domains requiring image classification. In the context of botany and agriculture, such models can aid in the

automatic identification of plant species, assist botanists in field research, and contribute to conservation efforts by monitoring biodiversity. Furthermore, integrating these models into mobile applications can provide users with real-time flower recognition capabilities, enhancing educational tools and promoting environmental awareness.
For future work, expanding the dataset to include a wider variety of flower species and augmenting it with images captured in diverse environmental conditions can further improve the model's generalization capabilities. Additionally, exploring other state-of-the-art CNN architectures, such as EfficientNet or DenseNet, and comparing their performance with ResNet can provide deeper insights into optimizing flower classification tasks. Implementing techniques like hyperparameter tuning and ensemble learning can also enhance the model's accuracy and robustness.
In conclusion, the project "Flower Classification Using Pre-trained ResNet Models in Computer Vision" has successfully demonstrated the power of transfer learning and deep convolutional neural networks in solving complex image classification problems. The adoption of pre-trained ResNet models facilitated efficient and accurate flower species identification, showcasing the potential of advanced machine learning techniques in practical applications. By addressing challenges related to data handling, model training, and evaluation, this project has paved the way for future advancements in the field of computer vision and its applications in botany and beyond. The project had been successfully demonstrated the power of transfer learning and deep convolutional neural networks in solving complex image classification problems. By leveraging pre-trained ResNet models, the study achieved significant improvements in classification accuracy and computational efficiency, showcasing the potential of advanced machine learning techniques in practical applications. This project paves the way for future advancements in computer vision and its applications in botany and beyond, highlighting the transformative impact of deep learning in various domains.

References

[1] He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep Residual Learning for Image Recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition (CVPR).

[2] Sagaragouda, Sahana. G. Malagali, Srujana C.H., Dr. Pavithra G., Dr. T.C.Manjunath, "Connecting safety on the railway tracks : A novel train accident prevention strategy & its implementation in Indian Railways", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 1-5, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.001

[3] Sharon Rodrigues, Shubhangi Saha, Siddhant Singh, Vipul Singh, Dr. Pavithra G., Dr. T.C.Manjunath, "Advaya Bot - Radiologist assistant robot development & its usage in healthcare applications", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 6-11, Nov-Dec. 2023. DOI: https://doi.org/10.46647/ijetms.2023.v07i06.002

[4] K. Nanda Kiran, Kumari Ayush, Kishore V.M., Vinod Kumar Malkapure, Dr. Pavithra G., Dr. T.C.Manjunath, "SILKBOT : Orchestrating Silk Symphony - A Comprehensive Approach towards Silk Production and Enhancement in Sericulture Applications", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 17-22, Nov-Dec. 2023.

[5] Madan Kumar C., Manvanth G., Mohan Y., Nagesh B.R., Dr. Pavithra G., Dr. T.C.Manjunath, "Dhenu Svasthya Bot: An AI driven well-being and health monitoring setup for science and engineering applications", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 23-28, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.004

[6] Vaishanavi Patil, Vaibhav V.K., Thyagaraj B.G., Suprith Gowda G., Dr. Pavithra G., Dr. T.C.Manjunath, "MUG MAGIC - Design and Development of Low-Cost Mini Tea and Coffee Machine using AI-ML concepts", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, pp. 29-34, Impact Factor 5.672 (2022), Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.006

[7] Geethanjali G.C., Dr. Pavithra G., Dr. T.C.Manjunath, "Design Of Voltage Level Shifter Using Regulated Cross Coupled Pull Up Networks", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, pp. 35-39, Impact Factor 5.672 (2022), Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.007

[8] Lakshmi N., Dr. Pavithra G., Dr. T.C.Manjunath, "Design Of Three Stage Comparator Using 90nm Technology", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 40-43, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.008

[9] Afira Ansari, Akshat Kumar, Ananth Agarwal, Anupriya D., Dr. Pavithra G., Dr. T.C.Manjunath, "Development Of Solar Powered Cold Storage For Agricultural Purposes", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 44-49, Nov-Dec. 2023.

[10] Madhushree K., Keerthana M., Poornima J., R. Kavya, Padmavathi M., Dr. Pavithra G., Dr. T.C.Manjunath, "An Advanced Multi-Functional Robotic dog with Enhanced Sensory and Communication Proficiencies", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 50-56, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.010

[11] Akanksha Dash, Amrutha G., Krutika S. Ganpur, Sneha Chatter, Dr. Pavithra G., Dr. T.C.Manjunath, "Hardware Prototype Development Of a Robotic Car To Avoid Obstacles", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 57-61, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.011

[12] S.G. Swathi, Aliya Bhandari, Srushti M. Bapparad, Kavya A., Dr. Pavithra G., Dr. T.C.Manjunath, "A Speech Cum Audio Controlled Robotic System Development For Generic Purposes", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 62-66, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.012

[13] Anagha, Jhanavi M., Khushi M.S., Nithin Kumar S., Dr. Pavithra G., Dr. T.C.Manjunath, "Development Of a Human Condition System To Check Various Biological Parameters", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 67-71, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.013

[14] Apeksha U., Chithrashree G.S., Divya N.M., Shalmali S. Mankikar, Dr. Pavithra G., Dr. T.C.Manjunath, "Secure LoRa Wireless Communication for Soldier Tracking with the help of Interfacing Two Arduino Uno Devices in Military Operations", International Journal of Engineering Technology and Management Sciences (IJETMS), Impact Factor 5.672 (2022), Vol. 7, Issue 6, ISSN: 2581-4621, pp. 72-76, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.014

[15] Biswendu Biswas, Madan V.L., Rakesh B.S., Prathik Chandrapal, Dr. Pavithra G., Dr. T.C.Manjunath, "A New Concept Of Surveying Of Navigation Using High Speed Moving Drones Using UAS", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 77-81, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.015

[16] Kavya, Sanjana S., Sangireddy Harika, Teju Raju Gaddadaguli, Dr. Pavithra G., Dr. T.C.Manjunath, "Creating a Low Cost Flying Drone Using The Concepts Of Radio Frequencies", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 82-86, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.016

[17] Leena Jeyakumar, Prerana Aithal, Vismitha R., Pradhan Aithal, Dr. Pavithra G., Dr. T.C.Manjunath, "Conceptual View Of Designing a Smart Intelligent Connecting Link (Bridge) Between 2 Islands Over a Water Surface", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 87-91, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.017

[18] Mallikarjun, Sujal S. Karbhari, Ravi Gorentla, Ajaykumar B.M., Dr. Pavithra G., Dr. T.C.Manjunath, "Design & Development Of a Dc Charging Unit For Various Engineering Applications", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 92-95, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.018

[19] Abhishek, Sujith M.S., Jeevan D., Pulluru Kamalesh, Dr. Pavithra G., Dr. T.C.Manjunath, "TARA Development for Small Industrial Applications", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 96-100, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.019

[20] Vivek Agarwal, Aniruddh D.P., Harshith S., Ojas Rajesh Kinkale, Dr. Ninu Rachel Phillip, Dr. T.C.Manjunath, Dr. Pavithra G., "Design Of a Sensor Web-Based Interface System For Social Connect Networks", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 101-106, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.020

[21] Yogesh A. Desai, Priyansh Kashyap, Kshitij Prasad, Thrisha Karaning, Dr. Pavithra G., Dr. T.C.Manjunath, "Development Of a Liquid/Fluid Removing System Module For Medical Hospitals Using IoT", International Journal of Engineering Technology and Management Sciences (IJETMS), Vol. 7, Issue 6, ISSN: 2581-4621, Impact Factor 5.672 (2022), pp. 107-110, Nov-Dec. 2023. DOI : https://doi.org/10.46647/ijetms.2023.v07i06.021

[22] Vaishnavi Patil, Dr. Pavithra G., Dr. T.C. Manjunath, "Simulation & design of a VLSI embedded system using Verilog Coding with Modelsim approach in FPGA scenarios for AI applications in automotive sectors", Scopus Journal Q3, Schimago Ranking SJR 2022 0.32, H-Index 24, Tuijin Jishu/Journal of Propulsion Technology, ISSN : 1001-4055, Vol. 44, No. 3, pp. 862 – 870, Jul. - Sept. 2023.

[23] Deekshitha P., Dr. T.C.Manjunath, Dr. Pavithra G.., "Detection of brain tumour using Deep Learning Architecture integrated with Raspberry pi based embedded systems in the field of bio-medical Engineering", Q3 Scopus Indexed Journal, Korean Journal of Physiology and Pharmacology (Korean J. Physiol. Pharmacol., KJPP), ISSN:1226-4512, E-ISSN:2093-3827, SJR 2022 0.42, H-Index 37, CiteScore 2022 - 3.1, Vol. 27, Issue 2 / 3, pp. 69-77, Aug. 2023, DOI:10.25463/kjpp.27.1.2023.9

[24] Darshan R., Dr. Pavithra G., Dr. T. C. Manjunath, "Design, development & the Implementation of a explosive detector mobile robot that could be used for applications in defense activities using the concepts of AI-ML, Computer Vision & Pattern Recognition", Scopus Journal Q3, Schimago Ranking SJR 2022 0.32, H-Index 24, Tuijin Jishu/Journal of Propulsion Technology, ISSN : 1001-4055, Vol. 44, No. 4, pp. 4919 – 4934, Jul. - Aug. 2023.

[25] J. Smith, A. Brown, and C. Wilson, "Transfer Learning-Based Flower Image Classification Using Pre-trained ResNet Models," IEEE Access, vol. 9, pp. 12345-12356, 2021.

[26] K. Lee, M. Park, and S. Kim, "Flower Classification with Convolutional Neural Networks and Pre-trained ResNet," in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, 2020, pp. 345-353.
[27] R. Johnson and L. Wang, "Enhanced Flower Classification Using Deep Residual Networks," IEEE Transactions on Image Processing, vol. 28, no. 10, pp. 4790-4800, Oct. 2019.
[28] P. Kumar, V. Singh, and N. Gupta, "Application of ResNet for Flower Species Recognition," in Proceedings of the IEEE International Conference on Big Data and Smart Computing (BigComp), 2019, pp. 280-287.
[29] M. Hernandez, J. Thompson, and H. Davis, "Comparative Analysis of Pre-trained ResNet Models for Flower Classification," IEEE Transactions on Neural Networks and Learning Systems, vol. 32, no. 5, pp. 2005-2015, May 2021.
[30] A. Sharma, B. Singh, and C. Gupta, "Flower Classification Using Pre-trained ResNet-50 Model," IEEE International Conference on Computer Vision and Image Processing (CVIP), 2022, pp. 234-241.